

-59-

CLAIMS

What is claimed is:

1        1.    A method for correcting for systematic  
2        errors in the writing of timing patterns on a storage  
3        medium of a storage device, said method comprising:

4                measuring a time interval between a trigger  
5        pattern written at a first radial position of  
6        said storage medium and a rotational index, said  
7        rotational index being related to the rotational  
8        orientation of the storage medium with respect  
9        to a fixed frame of said storage device; and

10               shifting location of another trigger  
11        pattern to be written, said shifting using said  
12        measured time interval in determining the shift  
13        in location for said another trigger pattern.

1        2.    The method of claim 1, further comprising  
2        computing an index correction value from a deviation  
3        between the measured time interval and another time  
4        interval, wherein said using uses said index  
5        correction value to shift said location of said  
6        trigger pattern.

1        3.    The method of claim 2, wherein said  
2        computing comprises subtracting said another time  
3        interval from the measured time interval to obtain  
4        said index correction value.

-60-

1 4. The method of claim 1, further comprising  
2 determining whether said measured time interval is  
3 valid.

1 5. The method of claim 4, wherein said  
2 determining comprises comparing said measured time  
3 interval to a first value to determine whether said  
4 measured time interval is valid, said first value  
5 comprising a function of a target index time and an  
6 allowed error from the target.

1 6. The method of claim 5, wherein said  
2 function comprises a summation of said target index  
3 time and said allowed error, and wherein said  
4 measured time interval is redetermined when said  
5 measured time interval is greater than said first  
6 value.

1 7. The method of claim 6, further comprising  
2 comparing said measured time interval to a second  
3 value when said first value is less than or equal to  
4 said measured time interval, said second value  
5 comprising a difference between said target index  
6 time and said allowed error from the target, wherein  
7 said measured time interval is invalid when said  
8 measured time interval is less than said second  
9 value.

-61-

1 8. The method of claim 7, further comprising:

2 determining whether a trigger pattern valid  
3 flag is valid, when said measured time interval  
4 is greater than or equal to said second value;  
5 and

6 updating an index estimate to be used in  
7 correcting one or more interval measurements,  
8 when said trigger pattern valid flag is valid  
9 and when said measured time interval is greater  
10 than or equal to said second value.

1 9. The method of claim 8, wherein said  
2 shifting comprises using said updated index estimate,  
3 which is a function of said measured time interval,  
4 in determining said shift.

1 10. The method of claim 4, further comprising  
2 updating an index estimate to be used in correcting  
3 one or more interval measurements, when said measured  
4 time interval is valid.

1 11. The method of claim 1, further comprising  
2 determining whether said trigger pattern is within an  
3 expected trigger pattern region.

-62-

1 12. The method of claim 11, wherein said  
2 determining comprises:

3 measuring an interval at said trigger  
4 pattern;

5 correcting said measured interval for any  
6 previous invalid trigger patterns; and

7 determining whether said corrected measured  
8 interval is valid, wherein a valid corrected  
9 measured interval indicates said trigger pattern  
10 is within said expected trigger pattern region.

1 13. The method of claim 12, wherein said  
2 determining whether said corrected measured interval  
3 is valid comprises:

4 subtracting a target interval value for  
5 said trigger pattern from said measured interval  
6 to obtain a resulting value; and

7 comparing an absolute value of said  
8 resulting value to a valid interval window to  
9 determine whether said corrected measured  
10 interval is valid, wherein said corrected  
11 measured interval is valid when said absolute  
12 value of said resulting value is less than or  
13 equal to said valid interval window.

1 14. The method of claim 13, further comprising  
2 modifying said valid interval window when said  
3 corrected measured interval is invalid.

1           16. The method of claim 15, further comprising  
2     generating said trigger pattern, as a false trigger  
3     pattern, when said trigger pattern is not detected at  
4     said given time.

-64-

1 17. A method for correcting for systematic  
2 errors in the writing of timing patterns on a storage  
3 medium of a storage device, said method comprising:  
4 determining a systematic delay for use in  
5 writing at least one trigger pattern at one  
6 radial position of said storage medium; and  
7 updating said systematic delay for use in  
8 writing at least one trigger pattern at another  
9 radial position of said storage medium, wherein  
10 said updated systematic delay is different from  
11 said systematic delay for use in writing at said  
12 one radial position.

-65-

1 18. The method of claim 17, wherein said  
2 updating comprises:

3 correcting one or more measured intervals  
4 of trigger patterns written at said one radial  
5 position;

6 computing a half/full measurement for said  
7 one or more corrected measured intervals;

8 updating a half/full error using said  
9 computed half/full measurement;

10 computing a delay correction using said  
11 half/full error; and

12 using said delay correction in updating  
13 said systematic delay.

1 19. The method of claim 18, wherein said  
2 updating comprises adding said delay correction to  
3 said systematic delay to obtain said updated  
4 systematic delay.

1 20. The method of claim 17, wherein said  
2 updating comprises using an index correction value  
3 indicative of the location of said at least one  
4 trigger pattern at said one radial position relative  
5 to a rotational index of the storage medium.

-66-

1        21. A method for correcting for systematic  
2 errors during self-servowriting of a storage device,  
3 said method comprising:

4            a) measuring a systematic error at a  
5 plurality of predetermined radial positions,  
6 wherein a measured systematic error for each of  
7 said plurality of predetermined radial positions  
8 having a mean whose absolute value is greater  
9 than zero is determined; and

10           b) correcting for each of the measured  
11 systematic errors in order to reduce said  
12 measured systematic errors.

1        22. The method of claim 21, wherein random  
2 errors in the placement of servo patterns are also  
3 corrected.



-67-

1 23. A method for self-servowriting a storage  
2 medium in a storage device including a head  
3 positioned for interaction with the storage medium,  
4 comprising:

5 writing a first set of trigger patterns on  
6 a first track of said storage medium;

7 determining a read to write time delay;

8 determining an index correction value;

9 determining at least one random error  
10 correction value;


11 computing a set of delay values which are a  
12 function of said read to write time delay, said  
13 index correction value and said at least one  
14 random error correction value; and

15 triggering from said first set of trigger  
16 patterns and writing a second set of trigger  
17 patterns on a subsequent track using said set of  
18 delay values.

-68-

1        24. The method of claim 23, wherein said  
2        determining said read to write time delay comprises:

3                writing a first trigger pattern at a first  
4        position on said storage medium;

5                triggering on said first trigger pattern  
6        and writing a second trigger pattern at a  
7        nominal time T; 

8                measuring a time interval between said  
9        first and said second trigger patterns; and

10                computing a difference between said time  
11        interval and the nominal time T to determine  
12        said read to write time delay.

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-70-

1 29. An apparatus for correcting for systematic  
2 errors in the writing of timing patterns on a storage  
3 medium of a storage device, said apparatus  
4 comprising:

5 a measuring unit adapted to measure a time  
6 interval between a trigger pattern written at a  
7 first radial position of said storage medium and  
8 a rotational index, said rotational index being  
9 related to the rotational orientation of the  
10 storage medium with respect to a fixed frame of  
11 said storage device; and

12 a controlling unit adapted to shift  
13 location of another trigger pattern to be  
14 written, said controlling unit using said  
15 measured time interval in determining the shift  
16 in location for said another trigger pattern.

1 30. The apparatus of claim 29, further  
2 comprising a computing unit adapted to compute an  
3 index correction value from a deviation between the  
4 measured time interval and another time interval, and  
5 wherein said controlling unit uses said index  
6 correction value to shift said location of said  
7 trigger pattern.

1 31. The apparatus of claim 30, wherein said  
2 computing unit is further adapted to subtract said  
3 another time interval from the measured time interval  
4 to obtain said index correction value.

-71-

1 32. The apparatus of claim 29, wherein said  
2 controlling unit is further adapted to determine  
3 whether said measured time interval is valid.

1 33. The apparatus of claim 32, wherein said  
2 controlling unit is further adapted to compare said  
3 measured time interval to a first value to determine  
4 whether said measured time interval is valid, said  
5 first value comprising a function of a target index  
6 time and an allowed error from the target.

1 34. The apparatus of claim 33, wherein said  
2 function comprises a summation of said target index  
3 time and said allowed error, and wherein said  
4 measured time interval is redetermined when said  
5 measured time interval is greater than said first  
6 value.

1 35. The apparatus of claim 34, wherein said  
2 controlling unit is further adapted to compare said  
3 measured time interval to a second value when said  
4 first value is less than or equal to said measured  
5 time interval, said second value comprising a  
6 difference between said target index time and said  
7 allowed error from the target, wherein said measured  
8 time interval is invalid when said measured time  
9 interval is less than said second value.

-72-

1 36. The apparatus of claim 35, wherein said  
2 controlling unit is further adapted to:

3 determine whether a trigger pattern valid  
4 flag is valid, when said measured time interval  
5 is greater than or equal to said second value;  
6 and

7 update an index estimate to be used in  
8 correcting one or more interval measurements,  
9 when said trigger pattern valid flag is valid  
10 and when said measured time interval is greater  
11 than or equal to said second value.

1 37. The apparatus of claim 36, wherein said  
2 controlling unit is further adapted to use said  
3 updated index estimate, which is a function of said  
4 measured time interval, in determining said shift.

1 38. The apparatus of claim 32, wherein said  
2 controlling unit is further adapted to update an  
3 index estimate to be used in correcting one or more  
4 interval measurements, when said measured time  
5 interval is valid.

1 39. The apparatus of claim 29, wherein said  
2 controlling unit is further adapted to determine  
3 whether said trigger pattern is within an expected  
4 trigger pattern region.

-73-

1 40. The apparatus of claim 39, wherein said  
2 controlling unit is further adapted to:

3 measure an interval at said trigger  
4 pattern;

5 correct said measured interval for any  
6 previous invalid trigger patterns; and

7 determine whether said corrected measured  
8 interval is valid, wherein a valid corrected  
9 measured interval indicates said trigger pattern  
10 is within said expected trigger pattern region.

1 41. The apparatus of claim 40, wherein said  
2 controlling unit is further adapted to:

3 subtract a target interval value for said  
4 trigger pattern from said measured interval to  
5 obtain a resulting value; and

6 compare an absolute value of said resulting  
7 value to a valid interval window to determine  
8 whether said corrected measured interval is  
9 valid, wherein said corrected measured interval  
10 is valid when said absolute value of said  
11 resulting value is less than or equal to said  
12 valid interval window.

1 42. The apparatus of claim 41, wherein said  
2 controlling unit is further adapted to modify said  
3 valid interval window when said corrected measured  
4 interval is invalid.

-74-

1 43. The apparatus of claim 29, further  
2 comprising a detector adapted to detect whether said  
3 trigger pattern is at an expected location on said  
4 storage medium at a given time.

1 44. The apparatus of claim 43, further  
2 comprising a pattern generator adapted to generate  
3 said trigger pattern, as a false trigger pattern,  
4 when said trigger pattern is not detected at said  
5 given time.

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-75-

1           45. An apparatus for correcting for systematic  
2 errors in the writing of timing patterns on a storage  
3 medium of a storage device, said apparatus  
4 comprising:

5           a processing unit adapted to determine a  
6 systematic delay for use in writing at least one  
7 trigger pattern at one radial position of said  
8 storage medium; and

9           said processing unit being further adapted  
10 to update said systematic delay for use in  
11 writing at least one trigger pattern at another  
12 radial position of said storage medium, wherein  
13 said updated systematic delay is different from  
14 said systematic delay for use in writing at said  
15 one radial position.

-76-

1 46. The apparatus of claim 45, wherein said  
2 processing unit is further adapted to:

3 correct one or more measured intervals of  
4 trigger patterns written at said one radial  
5 position;

6 compute a half/full measurement for said  
7 one or more corrected measured intervals;

8 update a half/full error using said  
9 computed half/full measurement;

10 compute a delay correction using said  
11 half/full error; and

12 use said delay correction in updating said  
13 systematic delay.

1 47. The apparatus of claim 46, wherein said  
2 processing unit is further adapted to add said delay  
3 correction to said systematic delay to obtain said  
4 updated systematic delay.

1 48. The apparatus of claim 45, wherein said  
2 processing unit is further adapted to use an index  
3 correction value indicative of the location of said  
4 at least one trigger pattern at said one radial  
5 position relative to a rotational index of the  
6 storage medium in updating said systematic delay.

-77-

1        49. An apparatus for correcting for systematic  
2 errors during self-servowriting of a storage device,  
3 said apparatus comprising:

4            a measuring unit adapted to measure a  
5 systematic error at a plurality of predetermined  
6 radial positions, wherein a measured systematic  
7 error for each of said plurality of  
8 predetermined radial positions having a mean  
9 whose absolute value is greater than zero is  
10 determined; and

11           a controlling unit adapted to correct each  
12 of the measured systematic errors in order to  
13 reduce said measured systematic errors.

1        50. The apparatus of claim 49, wherein said  
2 controlling unit is further adapted to correct for  
3 random errors in the placement of servo patterns.

-78-

1 51. An apparatus for self-servowriting a  
2 storage medium in a storage device including a head  
3 positioned for interaction with the storage medium,  
4 comprising:

5 a first set of trigger patterns written on  
6 a first track of said storage medium;

7 a controlling unit adapted to determine a  
8 read to write time delay, an index correction  
9 value, and at least one random error correction  
10 value;

11 a computing unit adapted to compute a set  
12 of delay values which are a function of said  
13 read to write time delay, said index correction  
14 value and said at least one random error  
15 correction value;

16 a pattern detector adapted to trigger from  
17 said first set of trigger patterns to write a  
18 second set of trigger patterns; and

19 a pattern generator adapted to write said  
20 second set of trigger patterns on a subsequent  
21 track using said set of delay values.

-79-

1 52. The apparatus of claim 51, wherein said  
2 controlling unit adapted to determine said read to  
3 write time delay comprises:

4 a pattern generator adapted to write a  
5 first trigger pattern at a first position on  
6 said storage medium;

7 a pattern detector adapted to trigger on  
8 said first trigger pattern, wherein said pattern  
9 generator writes a second trigger pattern at a  
10 nominal time T;

11 a measuring unit adapted to measure a time  
12 interval between said first and said second  
13 trigger patterns; and

14 a computing unit adapted to compute a  
15 difference between said time interval and the  
16 nominal time T to determine said read to write  
17 time delay.

-80-

1 *Sub 53* 53. An apparatus for correcting for systematic  
2 errors in the writing of timing patterns on a storage  
3 medium by a head of a storage device, said apparatus  
4 comprising:

5 a controlling unit adapted to detect one or  
6 more circumferential systematic errors; and

7 said controlling unit being further adapted  
8 to correct for said one or more circumferential  
9 systematic errors.

1 54. The apparatus of claim 53, further  
2 comprising a computing unit adapted to compute an  
3 integral correction value for a time interval,  
4 wherein a non-zero integral indicates a  
5 circumferential error.

1 55. The apparatus of claim 54, wherein said  
2 computing unit is further adapted to add a random  
3 error correction for said time interval to said  
4 integral correction value to obtain said integral  
5 correction value.

1 56. The apparatus of claim 55, wherein said  
2 controlling unit is further adapted to calculate a  
3 target interval for said time interval, using said  
4 integral correction value to correct for said one or  
5 more circumferential errors.

-81-

1 57. A storage device comprising:

2 a storage medium; and

3 a head radially positioned by an actuator,  
4 said head adapted to write a self-servo timing  
5 pattern on said storage medium, wherein  
6 systematic errors are eliminated and rotation of  
7 said servo-pattern matches a trajectory traced  
8 out by the head in its radial motion across the  
9 storage medium.

1 58. The storage device of claim 57, wherein  
2 said head is adapted to write said servo-pattern such  
3 that random errors in a track to track alignment of  
4 the servo-patterns are statistically constant in  
5 their root mean square value across at least a  
6 desired portion of a surface of the storage medium.

1 59. The storage device of claim 57, wherein  
2 said head is adapted to write said servo-pattern such  
3 that random errors in a track to track alignment of  
4 the servo patterns are corrected in a manner that  
5 leads to a growth of errors that is less than the  
6 square root of the track number typical of a random  
7 walk process.

\* \* \* \* \*

B2 Cont.

add  
A2